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ABSTRACT

In the context of math education, students should achieve transferable understanding and skills that allow students to use math flexibly (such as understanding a percentage in a newspaper article), functional performance (such as being able to take medicine or use public transportation), and social knowledge (concepts necessary to interpret and make sense of the world). Social knowledge is based on mathematical concepts and important to know, regardless of whether the math is understood. Recognizing the importance of social knowledge has consequences for numeracy frameworks, teaching practices and student assessment. Measuring the learner's achievement can be done by testing or by performance of holistic tasks often presented in a portfolio of student work. Both the General Educational Development (GED) certificate in the United States and the Australian Certificate of General Education for Adults (CGEA) are used as measures of knowledge, but the GED and other certifications can distort good numeracy instruction. In numeracy education, the teacher has a responsibility to pass on the most significant mathematical social understanding of the world through real world examples. (Contains a chart, an example mathematical exercise, 3 teaching web sites and 13 references.) (SLR)

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Adult Numeracy Teaching – An Australian Focus on Social Contexts

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Abstract

There are three interconnected aspects to this presentation:

- *Teaching numeracy in social context is well embedded within both Australian numeracy frameworks and teaching practices. Some of the guiding documents and their origins are referred to. The purposes of accreditation are questioned. Testing (regardless of which calculator you use) is compared unfavorably with ongoing assessment integrated into students' learning activities.*

- *A schema is proposed of what we desire students to achieve. In addition to **functional performance** (such as catching public transport, banking, household measuring) and **transferable understanding and skills**, an additional category of **social knowledge or understanding** is described.*

  It is questioned whether there is particular socially important knowledge, based on understanding of mathematically encoded information, which numeracy teachers ought to teach explicitly. Examples will be given such as, in the U.S. context, the importance of teachers supplying numerical facts about the correlation between gun availability and gun death.

- *Various teaching activities are offered to contribute to the direct practical usefulness of the Conference. They feature the Olympics, fitness, kitchen design, gambling, measurement sampling using alternative units (but there is only space for one here), and some Australian Internet sites are indicated.*

This presentation introduces approaches to numeracy teaching in Australia, particularly emphasising the social contexts of what is learnt, and indicating my own position on some pertinent issues.

Contents

This presentation refers to:

- A schema of what numeracy teaching involves.
- A common statement of numeracy knowledge domains.
- The Australian attempt to portray numeracy in genres similar to those used for literacy.
- Some reflection on assessment, accreditation, and course outcomes.
- Particular socially important knowledge based on understanding of mathematically encoded information which numeracy teachers ought to teach explicitly (which is the key point).
- Professional development and teaching materials created by the leading group of Australian numeracy developers.

What Should Students Achieve?

To know how we ought to teach we need to answer the question "What should students achieve?" Plato thought it was *arete* (virtues/excellence), then wondered what constituted *arete*. We have more limited aims here.

A number of precepts will be taken for granted; the gamut of adult learning principles which render the whole enterprise learner-focused. Within that, my schema of numeracy achievement, and hence numeracy teaching, involves:

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- Transferable understanding & skills.
- Functional performance.
- Social knowledge.

The idea of **transferable understanding & skills** is well understood. As the U.S. National Council of Teachers of Mathematics (NCTM, 2000, p. 5) puts it in their Principles and Standards: "When students understand Mathematics, they are able to use their knowledge flexibly." In a social context an example would be for a student to understand the meaning of a percentage when they come across it in a newspaper article.

Functional performance is similarly familiar to the adult numeracy field. Relevant social examples of functional performance include being able to take medicines, follow recipes, check change when shopping, catch public transport, and use automatic banking machines.

These first two categories have been well discussed, most recently by Ciancone and Tout at ALM7, but the third, **social knowledge**, though widespread in the practice of low-level numeracy teachers, has not been articulated, recognised, and developed as it could be. This formal overlooking hitherto has consequences for the governing frameworks describing what we want students to *know* in addition to what they are able to *do*.

Social Knowledge

This category of knowledge is important information, which numerically skilled people, such as numeracy teachers, know about the society and world they live in. It includes the good advice teachers typically give their students. A state of partial understanding, of knowing without totally knowing, is exemplified when we may understand some of the precepts and consequences of theories of relativity or quantum mechanics without ever having followed the mathematics. Many professionals who regularly apply statistical tests in their line of work do so without ever having comprehended the mathematical derivation of those tests. There is much about the world, both natural and social, which is based on mathematical understandings, and important to know regardless of whether the mathematics is itself understood. Numeracy teachers regularly teach their students such facts, and it is worth recognising this as part of the adult numeracy curriculum.

Before further developing this idea, we will examine briefly other conceptions of numeracy teaching, quickly surveying the development and strength of the "social" in numeracy teaching in Australia, and some issues in reporting student achievement.

As an example of how well established the "social" approach is in Australia, these quotes are taken from an end-of-course report by a teacher about her class:

> These skills are required to interpret and make sense of the world, and so should be taught not in isolation, but as part of other contexts and applications.
>
> Mathematical literacy is essential for full participation in Australian society. Adults need to be able to interpret graphs, tables and leaflets. The ability to talk about and describe different shapes, to follow and give directions and to measure are everyday skills which require maths to be seen as part of our language and culture. (CARWP, 1994)

In Australia socially-contextualised numeracy teaching practices have been developed through the numeracy stream of the Certificate of General Education for Adults (CGEA). The first version of the CGEA divided mathematics into five strands: number, space and shape, data, measurement, and algebra. Such arrays of mathematics topics are standard worldwide. We find similar categorisations used in Canada (Ciancone, 2000) and in school mathematics in the U.S. (NCTM, 2000). Such lists of topics are useful for checking that your teaching is covering a breadth of mathematics fields. In Australia a rather different schema is now being tried.

Five ways to make meaning in mathematics were put forward by Betty Johnson (1994, p. 32, quoted in Tout, 1999). These are through:

- **ritual**, where meaning is acquired by rote learning of atomised content;
- **conceptual engagement**, where mathematical meaning is constructed through problem-solving, process, and cognitive dissonance;
- **use**, where meaning is developed through use in everyday contexts;
- **historical and cultural understanding**, where meaning is enhanced by an understanding of the genesis and cultural use of specific mathematics; and
- **critical engagement**, where meaning is generated by asking "in whose interest?" and also questions about the appropriateness and limits of the maths model in the real situation.

Adult literacy teaching in Australia has been strongly influenced by systemic functional linguistics and the genre theorists. A schema for the practical teaching of reading and writing has been provided in the work of Rob McCormack et al. (Bradshaw, 1993, p. 137). They used genres of literacy as procedure, as public debate, as self-expression, and as knowledge to describe the literate repertoire. Stressing the **purposes** of everyday mathematics Beth Marr et al. have tried to mirror this categorisation in numeracy, yielding Numeracy for Practical Purposes, for Interpreting Society, for Personal Organisation, and for Knowledge.

- **Practical Purposes** addresses aspects of the physical world to do with designing, making, and measuring.
- **Interpreting Society** relates to interpreting and reflecting on numerical and graphical information of relevance to self, work, or community.
- **Personal Organisation** focuses on the numeracy requirements for personal organizational matters involving money, time, and travel.
- **Knowledge** deals with mathematical skills needed for further study in mathematics, or other subjects with mathematical underpinnings and/or assumptions. There are learning outcomes to do with problem solving, and algebraic and graphical techniques.

This was a bold vision. In hindsight it seems neither entirely successful, nor necessary. The rubric associated with description of performance becomes overly specific, and potentially bureaucratic in its application to teaching and assessment. In practice, these genres simply do not fit as well in numeracy as they do for describing writing.

Measuring Learner Achievement Testing? Or Performance of Holistic Tasks?
In Australia, and increasingly in some other countries (Ireland, for instance), assessment is based on a portfolio of student work in which the student evidences competence with the numeracy in question. The new NCTM Principles and Standards for School Mathematics (2000, p. 5) hold that "Assessment should be an integral part of instruction that guides teachers and enhances student learning. Teachers should be continually gathering information about their students."

What distortion does the GED test in the U.S. bring to good numeracy teaching?
Indeed, assessment is an integral part of teaching processes (though not of learning processes). But the rationale of assessment for certification ought to be carefully considered. What is the accreditation for? The learner, the teacher, the teaching institution, third parties? Who actually uses the Certificate? What difference does the Certificate actually make? The answers differ markedly from one country to another.

In the U.S. a high school certificate or its equivalent, the General Educational Development Certificate (GED), plays a large role in adult access to further study, acting as a hurdle to be overcome. Lacking one has consequences. Yet most research shows negligible economic consequences of GED success (NCSALL Research Briefs).

In Australia, with the notable exception of entry to the armed forces, the CGEA is almost entirely without consequence, except psychologically to the learner, and to the bean-counters in funding bodies who want to be assured that courses achieve outcomes. Adults (over 23) can usually gain access to further study without specifically obtaining high school equivalence.

The CGEA was created to give strategic legitimacy to an education field in danger of being overlooked, because it was not part of the school and vocational mainstream.

The U.S. National Center for the Study of Adult Learning and Literacy (NCSALL) has begun good work identifying what it is that students gain from our courses. Bingman (2000, p. 14) informs us that learners reported

> changes in their lives that were varied, contextual, and inter-related. Measuring changes in educational levels with standardized tests will not give programs and policy makers information about these outcomes. The tests are neither broad enough nor sensitive enough to capture the changes that matter to learners or to measure the performance of programs in supporting these changes.

Bingman et al. (1999, p. 1) had previously pointed out that "the other positive changes occurring in students' lives, especially those outside the classroom, generally are not assessed, perhaps because they are difficult to track and to measure."

Whom do we teach? Mostly legally competent adults, who themselves are the individuals best placed to decide whether a course is beneficial to them. Anecdotal reporting by learners can be a valid measure of course success.

Social Knowledge: Actual "Mathematical" Information about the Student's World

The excellent new adult numeracy TV series being produced in New York, TV411, has a segment in which rent-to-buy (hire-purchase) is shown to be much more expensive than straight-out purchase. This is an example of the sort of knowledge we are advocating be taught directly to our students **whether or not they understand the mathematics behind it.** Numeracy teachers are in a position to provide introductions to more complex mathematical ideas of particular relevance, without teaching the mathematics in full.

The teacher has a responsibility to pass on the most significant **mathematical** social (and natural) understandings of the world that they have. Examples of this are:

- If you gamble in a net loss game, it is increasingly likely over time that you will lose, and lose more (see teaching example below).
- In Australia, each withdrawal from a cheque account is taxed. So if you use a cheque account as your every day account, say, making frequent small withdrawals from automated teller machines, you pay a lot of tax.

In the U.S. context appropriate social facts to teach may be that

- The rate of gun death in the U.S. is four times that of Australia, and more than 20 times that of Britain. The table below illustrates this, but a bar graph would be much more effective, though setting appropriate scales would be difficult for students, with the U.S. disappearing off the page and Japan hardly visible (CSGV, 2000).
- With new gun restrictions in Victoria, Australia, domestic gun murders of women fell (Halloran, 1993).

Such numerical facts do not replace debates about freedom and gun availability, but they do inform them significantly.

DEATHS DUE TO FIREARMS
(rates are per 100,000 people)

	Total Firearm Deaths		Firearm Homicides		Suicides		Fatal Accidents	
	Rate	Number	Rate	Number	Rate	Number	Rate	Number
United States (1995)	13.7	35,957	6.0	15,835	7.0	18,503	0.5	1,225
United Kingdom (1994)	0.57	277	0.13	72	0.33	193	0.02	12
Australia (1994)	3.05	536	0.56	96	2.38	420	0.11	20
Canada (1994)	4.08	1,189	0.6	176	3.35	975	0.13	38
Germany (1995)	1.47	1,197	0.21	168	1.23	1,004	0.03	25
Japan (1995)	0.07	93	0.03	34	0.04	49	0.01	10

A Class Activity with Sampling/Statistical Content:
Principles of Gambling, or the Immorality of Unfair Games
All commercial gambling activities (that are not completely fraudulent) run on a basis similar to this game.

Take **three** coins. Bet one dollar. You toss the coins.
If you get two heads exactly (tails if you prefer), I'll give you back two dollars, i.e., you would win a dollar.
Do you want to play?

How about this one then? Take **two** coins. Bet one dollar. Throw two heads, and I'll give you back 3 dollars!
Roll up! Roll up!

Now we play until most of you are convinced that you are losers at this game, and in (almost) any case we can see that there are more people who have lost more money than a lucky winner may have won.

This may be thought to be a scheme to supplement casual teachers' paltry wages, but the main aim is to have you understand how gambling games work. They are set up as net loss games for the players.

Using a decision tree we can construct a plan of all possibilities and then compare the numbers of winning outcomes with losing outcomes to work out how the payout differs from what would be paid out if these were fair games.

Can you construct a simple game (simple enough for us to later demonstrate the mathematics of it) that looks attractive to players on first glance, but fleeces them nevertheless?

Australian Resources
In Australia the triumvirate of Beth Marr, Betty Johnson, and Dave Tout have played towering roles in the creation of the field of adult numeracy teaching. Their teaching resources and professional development materials are highly regarded for their specific application in teaching adults.

Finally, some numeracy teaching sites which may be beneficial:

http://www.staff.vu.edu.au/mcaonline
This site, created by Syed Javed and colleagues at VUT, provides interactive assistance with mathematics learning at a wide range of levels, but lacks the social contextualisation distinctive of the Australian contribution in this field.

http://sunsite.anu.edu.au/language-australia/numeracy
This site is managed by Dave Tout. It includes a bank of numeracy lessons written by teachers from around Australia.

http://www.vicnet.net.au/~acenet/newspaper.html
This site is managed by Dale Pobega. It has a range of CGEA online numeracy courses.

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